

### **REMARKS**

Applicants appreciate the Examiner's thorough consideration provided the present application. Claims 37-44 are now present in the application. Claims 37, 39 and 44 have been amended. Claim 37 is independent. Reconsideration of this application, as amended, is respectfully requested.

#### **Claim Rejections Under 35 U.S.C. §§ 102 & 103**

Claims 37 and 39-43 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Kobayashi, U.S. Patent No. 4,829,022. Claims 37-43 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nishizawa, U.S. Patent No. 5,693,139, in view of Kobayashi. Claim 44 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Nishizawa in view of Kobayashi, and further in view of Edmond, U.S. Patent No. 5,739,554, and Manabe, U.S. Patent No. 6,472,690. These rejections are respectfully traversed.

In light of the foregoing amendments to the claims, Applicants respectfully submit that these rejections have been obviated and/or rendered moot. As the Examiner will note, independent claim 37 has been amended to recite a combination of steps including "supplying a first crystal raw material to form a first layer; after the step of supplying a first crystal raw material stops, supplying a second crystal raw material different from the first crystal raw material to form a second layer on the first layer; supplying at least one p-type impurity raw material and at least one n-type impurity raw material before the step of supplying the second crystal raw material, thereby doping an impurity pair of the at least one p-type impurity raw material and the at least one n-type impurity raw material into only the first layer, wherein a kind

of impurity pairs composed of the p-type impurity raw material and the n-type impurity raw material are formed in the first layer.”

Support for the amendments to claim 37 can be found in FIGs. 2, 3, 7 and 8 and the corresponding description of the specification (e.g., page 14, lines 14-18, page 15, lines 2-5, page 21, lines 9-13 and page 22, lines 7-12) as originally filed. Applicants respectfully submit that the above combination of elements as set forth in amended independent claim 37 is not disclosed nor suggested by the references relied on by the Examiner.

In particular, the Examiner has correctly acknowledged that Nishizawa fails to teach each and every element in claim 37. In fact, Nishizawa merely discloses a method of alternate introduction of donors to each layer.

The Examiner alleged that Kobayashi in col. 12, lines 35-50 discloses “supplying at least one p-type impurity raw material and at least one n-type impurity raw material before the step of supplying the second crystal raw material, thereby doping an impurity pair of the at least one p-type impurity raw material and the at least one n-type impurity raw material into only the first layer” as recited in claim 37. Applicants respectfully disagree.

In particular, Kobayashi in col. 12, lines 35-50 simply discloses that a material which is to be the host and an impurity raw material are supplied simultaneously. Kobayashi nowhere discloses that a p-type impurity and an n-type impurity are supplied simultaneously. More specifically, Kobayashi in col. 12, lines 38-47 discloses, for fabricating *PN junction*, “Beryllium as a p-type impurity and Si as an n-type impurity were supplied simultaneously with the supply of atoms of Group III”, which simply means that supplying atoms of Group III which are the host with one of p-type impurity raw material and n-type impurity raw material.

Since there are a sufficient number of carriers in the system of Kobayashi, it is not necessary to increase the number of carriers by the co-doping. In fact, the idea of the co-doping itself had not been introduced in 1989 when Kobayashi was filed. More specifically, Kobayashi simply discloses that the flat superlattice is made by alternate supply with the MBE method. Therefore, it is clear that only a kind of impurity raw material (not impurity pair) is doped.

On the other hand, the present invention realizes that the level is lowered in band-gap of acceptors or donors by doping the p-type impurity raw material and n-type impurity raw material at the same time or alternately, and forming “impurity pairs composed of the p-type impurity raw material and the n-type impurity raw material... in the first layer” so that a lot of carriers appear. Therefore, the present invention is completely different from Kobayashi, and Kobayashi fails to teach “supplying at least one p-type impurity raw material and at least one n-type impurity raw material before the step of supplying the second crystal raw material, thereby doping an impurity pair of the at least one p-type impurity raw material and the at least one n-type impurity raw material into only the first layer, wherein a kind of impurity pairs composed of the p-type impurity raw material and the n-type impurity raw material are formed in the first layer” as recited in claim 37.

Furthermore, the present invention discloses the doping techniques of the deep ultraviolet semiconductor optical device which can be operated in the deep ultraviolet area. Since a band gap is wide in the deep ultraviolet area, the carrier concentration is low. The present invention provides an exclusive method which can dope with the high concentration that cannot be achieved in the past. For example, as shown in FIG. 8 of the present application, the present

invention increases the carrier concentration by doping both of the n-type dopant, Si, and the p-type dopant, Mg, in one layer. These features are clearly absent from Nishizawa and Kobayashi.

With regard to the Examiner's reliance on the other secondary references, these references have only been relied on against dependent claim 44. These references also fail to disclose the above combination of steps as set forth in amended independent claim 37. Accordingly, this reference also fails to cure the deficiencies of Nishizawa and Kobayashi.

For example, although Edmond discloses a co-doping method, the issue is how to realize the co-doping method. If a lot of donor materials and acceptor materials are introduced at the same time, the donor-acceptor complexes are formed in some small measure. However, the crystalline becomes worse and the hole concentration is decreased by the compensating effect of donor and acceptor. Edmond discloses that the Valence electron was controlled by supplying two kinds of atoms into the crystal at the same time, and this achieved the co-doping. However, in such a process, since it is not easy for the impurity materials to move in the crystal, the probability of forming the acceptor which is the state of the associating three atoms is low.

On the other hand, in the present invention, the donor level or the acceptor level which is shallow is formed by supplying the p-type impurity materials and the n-type impurity materials into the same atomic layer at the same time or alternately, and forming the "impurity pairs composed of the p-type impurity raw material and the n-type impurity raw material". Accordingly, the present invention provides features that the activation energy is lower and the carrier concentration increases, which are clearly absent from the utilized references.

Accordingly, none of the utilized references individually or in combination teach or suggest the limitations of amended independent claim 37. Therefore, Applicants respectfully

submit that amended independent claim 37 clearly define over the teachings of the utilized references.

In addition, claims 38-44 depend, either directly or indirectly, from independent claims 37, and are therefore allowable based on their respective dependence from independent claim 37, which is believed to be allowable.

In view of the above remarks, Applicants respectfully submit that claims 37-44 clearly define the present invention over the references relied on by the Examiner. Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. §§ 102 and 103 are respectfully requested.

### **CONCLUSION**

It is believed that a full and complete response has been made to the Office Action, and that as such, the Examiner is respectfully requested to send the application to Issue.

In the event there are any matters remaining in this application, the Examiner is invited to contact Cheng-Kang (Greg) Hsu, Registration No. 61,007 at (703) 205-8000 in the Washington, D.C. area.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicants respectfully petition for a three (3) month extension of time for filing a response in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

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Respectfully submitted,

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